



Spatiality of regional inequality

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ABSTRACT

Spatial inequality has drawn renewed scholarly interests and societal concerns. This paper reviews the literature on regional inequality, with a focus on spatiality of regional economic/income inequality, to make a timely contribution for a better understanding of the complexity and dynamics of spatial inequality. We find that existing theories disagree over temporal trends and underlying forces of regional inequality, and spatio-temporal models have been favored by economic geographers. It also shows that the research on regional inequality covers all continents of the world, including both developed and developing countries. The scope of research has also been broadened, expanding to household and environmental inequalities. The paper proposes components of spatiality of regional inequality, including scale, location, physical geography, place, space, spatial network, and spatial-temporal models. The paper also proposes areas for future research.

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Introduction

Inequality is a fundamental issue for human society, a core subject of academic inquiry, and a major concern of governments. There has been a long-lasting debate about the extent, dimensions, trajectory, mechanisms and consequences of geographical inequality, as well as policies that address poverty and inequality. This debate has been dominated by convergence (e.g., neoclassical economics) and divergence (e.g., dependency, neo-Marxism) schools. Concerns for the negative effects of globalization and liberalization and the unequal benefits of the transition in socialist countries have generated renewed debates since the late 1980s. Thanks largely to the uneven consequences of the recent global financial crisis and recovery, income inequality in many countries is at historic levels with protesters raising the voices of unfair capitalist system (Stiglitz, 2012). Spatial inequality as a key component of inequality has also drawn renewed scholarly interests and societal concerns. This special issue is a timely effort to examine the complexity and dynamics of spatial inequality, with a focus on spatiality of regional economic/income inequality.

Theoretical pluralism and debates characterize the research on regional inequality. We borrow Kuhn's ideas of paradigms and paradigm shift to review theories and empirics of regional inequality. For convenience and based on changes in society and

social sciences, this article divides academic inquiry of regional inequality into five periods with roughly 20 years each: 1930s–1940s, 1950s–1960s, 1970s–1980s, 1990s–2000s, and 2010s–present. Societal change and paradigm shifts over the last 80 years reflect the reality of the regional inequality literature: the disagreement of scholars over theories of regional inequality and controversial empirical findings indicates the complexity and dynamics of inequality. While economics has been ruled by neoclassical economics, economic geographers tend to be more plural and spatially oriented.

Prior to the Great depression of the 1930s, the mainstream economic thought was dominated by the general equilibrium theory. This was challenged by Keynesian economics, which provided demand-side thinking and paving the way for government intervention. The 1930s were also the time when Hartshorne clarified the nature of geography as the study of a real differentiation of the earth's surface, which placed the geography of inequality as the core subject of geography. Major theoretical advance only started in the 1950s after the World War II, with the development of the neoclassical convergence schools. However, despite the initial optimism for the modernization paradigm, poverty and inequality persisted, which, together with the Civil Rights Movement and the oil crisis, led to the popularity of structuralism in the 1970s and 1980s.

Globalization and reforms in socialist countries have renewed the debate on regional inequality since the 1990s. The neoclassical revival has also taken place in the research on regional inequality, represented by Barro and Sala-i-Martin (1991; 1992) new

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convergence theory. The recent global financial crisis and technological revolution have generated uneven recovery and distribution, which has stimulated a new round of thinking on inequality in the 2010s, making [Stiglitz \(2012\)](#) and [Piketty \(2014\)](#) authors of best-selling books. Inequality has once again become a hotly debated topic among top world leaders, including those of the United Nations, World Bank and the United States.

Neoclassical convergence theories: the 1950s–1960s

Theories of regional inequality have been heavily influenced by neoclassical economics and the notion of long-term convergence, although economics has become more plural over time. Neoclassical economics and growth pole models maintain that factor mobility and diffusion tend to equalize regional differentials in the long run. Such views of neoclassical economics and modernization theory were dominant in the 1950s and 1960s.

Neoclassical convergence theories

The neoclassical growth theory emphasizes equilibrium conditions and the importance of the market in allocating resources and considers regional inequality as a transitory phenomenon. It stresses the influence of the supply-side factors such as labor, capital stock, and technological change, and views regional growth as a process of resource reallocation, i.e. the mobility of capital and labor. According to [Borts and Stein \(1964\)](#), while labor tends to move to more developed regions with higher wages, capital tends to move to labor-intensive and more profitable sectors in less developed regions. This condition eventually equalizes wages and the price of capital and reduces regional income differentials. The neoclassical convergence theory therefore holds that regional inequality rises from temporary disequilibrium between supply and demand; efficient markets and factor mobility tend to equalize regional differentials in long run. The regional export base model also projects long-term regional convergence and stresses the role of the export base and the trade of goods in regional development.

Core-periphery dynamics and the inverted-U model

The inverted-U model, influenced by the Kuznets inverted U-shape theory of income inequality and Rostow's stage theory of economic growth, argues that regional inequality tends to rise during the early stage of development and fall as the economy matures ([Williamson, 1965](#)). [Kuznets \(1966\)](#) was concerned with high birth rates in developing countries but insists that regional income inequality would eventually decline. This school is attractive as it accommodates both the convergence and divergence models as well as provides a basis for policy intervention. The Kuznets curve concept has also been applied in environmental pollution, which is known as environmental Kuznets curve. Scholars find that many countries, including China, do go through such a Kuznets' process ([Zhang & Bao, 2015](#)).

[Perroux's \(1950\)](#) growth poles serve as the engines of regional growth. While agglomeration economics and Myrdalian backwash effect cause early polarization, diffusion and redistribution would eventually occur. [Friedmann's \(1966\)](#) core-periphery model holds that though development originates in a few core regions and tends to self-reinforce, it would trickle down to the periphery and eventually functionally interdependent spatial systems would emerge. The notion of long term convergence and prosperity could be found in dominant urban and regional development theories, including the central place theory and urban system theories. [Alonso \(1980\)](#) summarizes five bell shapes in development: development stages, social inequality, regional inequality,

geographic concentration and demographic transition. This paradigm of regional development is also known as top-down development, or development from above ([Hansen, 1981](#)). Despite development and change over years, scholars can still identify the core-periphery structure in regional development ([Liao & Wei, 2015](#); [Poon, Tan, & Yin, 2015](#)).

The cumulative causation thesis

While neoclassical growth models have been influential in regional development, disagreements have persisted over time. [Myrdal's \(1957\)](#) cumulative causation mode argues that the negative backwash effect tends to reinforce regional inequality, though in the long run, the spread effect can induce the development of backward regions; the process of regional development is self-reinforcing and growth rate differentials tend to persist and even widen over time. Capital and labor tend to flow at the same direction, i.e., from the periphery to the core where more opportunities and better returns are available. Thus, while factor mobility stimulates regional divergence, rather than convergence, the divergence models allow for increasing returns to scale. Moreover, human capital and technology also favor the core and facilitate regional divergence. Policy intervention is necessary to counter the imperative of the free market and to reduce regional inequality.

The critique, empowerment and structural models: 1970s–1980s

Since the late 1960s, a great deal of theoretical debates and empirical tests have been generated across countries in the world. Scholars who support convergence and inverted-U models find that in countries such as the United States and Japan, regional inequality has experienced a long-term decline, although they disagree over sources of income convergence (e.g., [Barro & Sala-i-Martin, 1992](#); [Crown & Wheat, 1995](#); [Mera, 1977](#); [Tabuchi, 1988](#)). Findings in developing and socialist countries tend to be mixed (e.g., [Fuchs & Demko, 1979](#); [Kanbur & Venables, 2005](#); [Royuela & García, 2015](#); [Schiffer, 1985](#); [Wei, 1999](#); [Zhang & Bao, 2015](#)). The persistence of poverty and inequality also triggered the civil rights movements in the United States and inspired new thinking on inequality, especially by critical geographers and development sociologists. In this context, a variety of structural models appeared as alternatives and debates on regional inequality intensified.

The critique of neoclassical theories

The debates on development and inequality have touched many issues. The term development itself is a controversial concept and neoclassical economics has been criticized for equalizing development with growth measured by GDP and/or income. The critique of neoclassical economics can be shortly summarized as the following: (1) Assumptions of the neoclassical economics (e.g., perfect competition, perfect information, and free factor mobility) are difficult to fulfill. Production factors are “sticky” and mobility is impeded in many countries ([Richardson, 1978](#)). Post-Keynesian economists argue that the allocation of the capital stock depends on its initial distribution and structural parameters such as saving and capital-output ratios. (2) Neoclassical economics overlooks the potential contribution of factors on the demand side of the market, and is weak in accounting for short-term changes, the open economy, and regional divergence ([Armstrong & Taylor, 1985](#)). (3) Cultural, institutional, and geographical factors may play significant roles in influencing trade, factor mobility, innovation and regional development ([Krugman, 1991](#); [Porter, 1990](#)). Alternatively,

economists developed endogenous growth theory, new economic geography, and institutional economics, among other developments.

The inverted-U model has also received numerous critiques since the 1970s (e.g., Gilbert & Goodman, 1976; Krebs, 1982; Stohr & Todtling, 1977): (1) Many countries were troubled by widespread poverty, weak diffusion and persistent regional inequality. (2) The market is not totally free but state intervention is less effective. (3) The Inverted-U model may be an exceptional case and the U.S. context is exceptional: spatially integrated market economy, sustained high rates of economic expansion, high rate of population mobility, long-term regional income convergence, cultural uniformity, and a federal system of government (Friedmann & Block, 1990). The causes of the long-run inverted-U pattern of regional inequality are still not well understood (Kim, 2008). Piketty (2014) argues that income inequality in the United States has grown sharply over the last thirty years and follows a U-shaped curve, rather than Kuznet's inverted-U curve. Similar patterns of rising inequality in the United States are found by Dorling (2015) and Essletzbichler (2015), as well as in Canada (Breau, 2015). Dorling (2015) also shows acute socioeconomic polarization in the UK.

The development from below paradigm

The debates over regional inequality have been intertwined with the broad debates on development and inequality and the critique of modernization theories. As a response to problems of underdevelopment and dependency, the development from below paradigm emerged in the 1970s, emphasizing empowerment, decentralized, territorial, agropolitan, and bottom-up approaches to regional development (Friedmann & Weaver, 1979; Rondinelli, 1985; Stohr & Todtling, 1977). This paradigm promotes endogenous and self-reliant regional development that addresses basic needs, utilizes local resources, promotes the development of small towns and reduces dependence relationships (Stohr & Taylor, 1981), with a strong rural emphasis. The process of decentralization, however, is also uneven, and may not necessarily lead to regional development, which relies on good and effective governance (Rodríguez-Pose & Hardy, 2015). Empowerment and local/community development have become major components of development approaches and policies today.

Neo-Marxism and structural models

Structural models tend to emphasize disequilibrium and divergence. The dependency school holds that the spread of capital to the periphery creates dependent core-peripheral structure, sustains labor outflow and unequal transfer, exacerbates the stagnation of the periphery, and intensifies regional inequality (Emmanuel, 1972; Frank, 1967). Slater (1975) argues that metropolitan areas appropriate the economic surplus from poor underdeveloped regions through their integration into the capitalist economy. Santos (1979) argues that the differences between the upper circuit and the subordinate lower circuit generate dramatic income disparities. Notions of dependent development and underdevelopment were further developed in world-systems analysis developed by Wallerstein. However, the dependency school has been criticized on several grounds. First, it exaggerates external forces in underdevelopment. Second, it views core-periphery structure as dependent and self-reinforcing, ignoring the interdependence and dynamics of the structure (Corbridge, 1986). Third, the core-periphery structure is too strict in practice (Knox & Agnew, 1994).

Regional inequality under capitalism has been seen as both necessary and inevitable from Marx's political economy

perspectives. The necessity thesis maintains that regional inequality is a necessary precondition for capital accumulation, and the periphery provides reserves of labor and markets necessary for capitalism (Harvey, 1975). The inevitability viewpoint holds that the capitalist mode of production actively creates, intensifies and maintains regional inequality, as capital tends to move to core areas with higher profit rates (Soja, 1980). As a result, the periphery is chronically deprived of investment and becomes a reserve of stagnant places. Firms take advantage of the differences in labor distribution and reinforce spatial division of labor that favors core over periphery and intensifies regional inequality (Clark, Gertler, & Whiteman, 1986; Storper & Walker, 1989). The necessity and inevitability theses have been criticized for relating to the dependency paradigm and ignoring the dynamics of capital accumulation and the difference that space makes (Duncan, 1989). Capital accumulation constantly constructs and deconstructs economic space, as well as equalizes and differentiates regional economy. Dissatisfied partially with structural Marxists' totalizing tendencies, Massey (1984) develops a theory of spatial division of labor that views the structure of local economies as a product of the combination of existing local conditions and layers of new rounds of investment.

Research on Fordist/post-Fordist production has also contributed to the study of regional inequality. Fordist mass production is organized by propulsive firms and is formed geographically in manufacturing regions, and stimulates urbanization and intensifies regional inequality. Post-Fordist production is characterized by flexible production, reinforcing agglomeration, and the development of industrial districts (Piore & Sabel, 1984; Scott, 1998). However, these theories have also received critiques for dualism between Fordism and post-Fordism, for ignoring the role of the nation-state, and for inadequate validity (Peck, 1992; Yeung, 1994). Post-structural theories and post-development thought have drawn more attentions to neoliberalism, institutions, gender, culture and ecology.

Globalization, the new world order and regional inequality

Since the late 1980s, globalization has become a critical dimension of our daily life. Regions have become more interconnected than ever and global forces have become influential in national and regional development (Dicken, 1998). Technology has been playing an even more important role in economic development. Globalization, technological development and societal change have inspired new thinking on regional development and inequality. The widely observed rising inequality since the recent Global Financial Crisis has ignited new debates and broad concerns on inequality (e.g., Piketty, 2014; Stiglitz, 2012).

Research on regional inequality has been heavily influenced by developments in economics, development studies, and economic geography. The concept of development has been expanded to include income distribution, human development, quality of life, happiness, and increasingly, sustainable development. Sen (1999) even defines development as freedom. The research on regional inequality has been flourishing at multiple scales, from individuals, households to neighborhoods, regions, and countries. Perspectives on the process of change have been shifted from a linear, progressive process or an inverted-U process towards a more dynamic and open evolutionary spatial-temporal process. The role of culture, institution, geography and the context of the Global South have also increasingly drawn scholarly attention. Institutional turn in economic geography and development in geographical techniques have also revitalized geographical research on regional inequality.

New convergence theory

As response to the critique on neoclassical economics and being triggered by new thinking on globalization, a miraculous resurgence of new growth theories, new economic geography, and institutional/evolutionary economics have totally reconfigured economics. These new models tend to emphasize increasing returns and provide more explaining power, with relaxed economic assumptions. Recent work by economists has advocated the notions of agglomeration and the cumulative causation process (e.g., Krugman, 1991). The endogenous growth theory argues that countries are rich in capital, highly educated, and favorable to knowledge accumulation as it tends to grow faster (e.g., Mankiw, Romer, & Weil, 1992).

Barro and Sala-i-Martin (1991; 1992) in particular have published a series of papers on regional inequality promoting convergence, which has since become the most influential contemporary theory of regional inequality. Two concepts of convergence have been identified and studied: (1) σ (sigma)-convergence, the most often studied, occurs when the dispersion of per capita income or outputs across regions declines over time; (2) β (beta)-convergence refers to the tendency for initially poorer regions to grow more rapidly than the richer regions. They argue for the convergence of income across regions, with β about 2 percent per year. Concepts of absolute, relative and club convergences have also been developed.

The new convergence theory has fueled fresh debates and empirical testing, and deserves a huge credit for revitalizing the study of regional inequality in mainstream economics. However, the endogenous growth theory has major limitations when applied to a regional context, and new economic geography has also been criticized for not taking space and geography seriously (e.g., Martin & Sunley, 1998). The macro modeling approach is insensitive to geographical scale and space, and often overlooks the process and bottom-up forces at work (Wei & Ye, 2009; Wei, Yu, & Chen, 2011). The notion of conditional convergence is limited since it removes a number of structural and local variables that significantly influence regional inequality (Petrakos, Rodriguez-Pose, & Rovolis, 2005).

Globalization, foreign investment and regional inequality

The globalization of economic activities has emerged as an important trend of the world economy (Dicken, 1998). A number of structural and technological forces have facilitated the globalization of production. Industrial organization/market imperfection theories have attempted to explain the globalization of capital by examining technology, organization structure, transaction costs, market power, and profit rates (Dunning, 1993; Kojima, 1982). The relocation of firms to overseas is also facilitated by two technical conditions: development in transportation and communication which reduces moving costs and improves travel efficiency, and changes in technology and production organization which make it possible to decompose complex production processes and perform with minimum labor skills.

The impact of globalization and global (external) forces on regional inequality is an important theme in the development literature. After all, regions within nations face most of the challenges of adjusting to the new world order (Feser, 2007). Some scholars have observed a trend of income convergence across countries (Barro & Sala-i-Martin, 1991), and have speculated the convergence and homogenization of the world and the emergence of “global villages”. Others have found varieties of capitalism, the survival of localism/regionalism, the localization of the global, and the emergence of new industrial districts and urban spaces (Scott, 1998; Storper, 1997). Scholars have addressed the localization of

global capital and the importance of local institutions and attributes in regional development (Amin and Thrift 1995). Borders still have effects on regional inequality dynamics (Rey & Sastre-Gutierrez, 2015).

Research on global forces and regional development is largely centered on foreign direct investment (FDI) and multinational enterprises (MNEs) or transnational corporations (TNCs), though other factors such as international trade, financial institutions and technological change are also considered. MNEs have evolved through three stages of development (Malecki, 1991): extracting natural resources and primary products from developing countries, market expansion among major countries, and recently, production moving offshore to developing countries, often called the globalization of production, accompanied by the globalization of finance, trade, and services and the formation of TNCs and global production networks. A large amount of FDI has been located in the newly industrializing countries (NICs) in Asia, especially China.

The penetration of global forces and the globalization of production tend to lead to the increase of urban primacy and regional inequality in developing countries (Kasarda & Crenshaw, 1991; Taylor & Thrift, 1982). FDI tends to be urban-biased and located in major cities and core regions in developing countries, as these places have advantages in infrastructure, labor force, and access to market and political power, as evidenced by the concentration of FDI in coastal China (Huang & Wei, 2011). TNCs are often thinly embedded with local economies, forming their own glocal production network and called by some as pseudo embeddedness (Liao & Wei, 2013, 2015). The spatial concentration of foreign capital tends to lead to a polarized process of urbanization and reinforces urban primacy and regional inequality (Armstrong & McGee, 1985; Li & Wei, 2010). World cities or global cities have also emerged as major centers for the distribution and accumulation of international capital (Friedmann, 1986). However, some scholars argue that foreign investment has little causal effect on regional inequality (Fuchs & Pernia, 1987; Knox & Agnew, 1994), largely due to state intervention and the spread of manufacturing investment in the peripheral regions. There is also a literature on mega projects and free trade zones, as well as their impact on urbanization and regional development.

The literature is limited on the impact of other dimensions of globalization such as foreign trade and innovation diffusion on regional inequality. Foreign trade tend to benefit cities and regions with locational and comparative advantages, such as port cities and coastal regions. However, some argue that, over time, such gaps tend to decline with the relocation of capital and industry to the periphery (Kim, 2008). There is a body of literature on free trade and its impact on communities and regions, particularly on the North American Free Trade Agreement (NAFTA) and the European Union. Regional trade agreements promote convergence among member countries and regions, but differentiate themselves from non-members (Berry, Fuillen, & Hendi, 2014). Foreign investment and trade clearly have winners and losers, and also impact environmental change and vulnerability. Technological change and the increasing demand for highly skilled workers are also likely contributing to the rise of inequality.

While FDI tends to locate in core regions of the developing countries and stimulate the widening of regional inequality, FDI distribution is dynamic and influenced by many factors, such as access to markets, state policy, labor forces, and transportation. Thus, the real picture of FDI distribution is much more complex; the impact of global forces on regional inequality varies across regions and countries. More studies are still needed to specifically assess the impact of globalization on regional inequality in developing countries.

Institutions, the state and regional inequality

Institutions play a significant role in economic development (North, 1990). An emerging body of literature has argued that the importance of institutions, including states and informal institutions in regional development, is much more than geography or trade (Appelbaum & Henderson, 1992; Rodríguez-Pose, 2013). Regional development pioneers, such as Hirschman, Friedmann and Alonso, argued for state intervention to reduce regional inequality. Bringing the state back in was an emerging theme of the literature in the 1980s (Evans, Rueschemeyer, & Skocpol, 1985). Acemoglu, Johnson, and Robinson (2002) emphasize the role of institutions rather than geographic factors in explaining economic prosperity among countries colonized by European powers. The role of the state has been particularly important to understand inequality in socialist countries (Wei, 2000). Geographers have also emphasized informal institutions, with the notions of institutional thickness, untraded interdependencies, and alternatively, institutional lock-in (Amin & Thrift, 1995; Storper, 1997).

Theories of the state and views of the state in regional development are inconsistent. Five functions of the state can be summarized: (1) supplier of public goods; (2) regulator and facilitator of the market-place; (3) social engineer; (4) arbiter among competing social groups; (5) instrument of ruling class (Clark & Dear, 1984). Neoclassical economics maintains that economic development relies on the free market; the state should adopt a free-market regime and provide public goods, since factor mobility would lead to regional convergence. In the Marxian analysis, the state is seen as an agent manipulating labor in the interest of capital and creating economic and social conditions favorable to capital accumulation; thus state actions tend to create, maintain, and intensify regional inequality (Clark & Dear, 1984). However, others argue that the state is not simply an instrument of capital and has a less significant role in regional divergence (Duncan, 1989).

A large body of empirical literature has analyzed the role of the state and the impact of state policies that may include macroeconomic and regional policies. The state is consisted of a set of institutions with conflicting goals (e.g., efficiency, equity and environment). Analysts argue that in developing countries, state policies, particularly policies promoting industrialization, foreign investment and trade, tend to stimulate the development of core regions and exacerbate regional inequality (Gilbert & Gugler, 1992; Lipton, 1977). Political corruption and instability may also contribute to the rise of urban primary and regional inequality (Kim, 2008). Governments in many countries have made some efforts to develop backward areas and reduce regional inequality. However, regional policies have had only limited effects and are often offset by macroeconomic policies, foreign investment, and local forces favoring the core regions. Thus, scholars tend to suggest that state policies in developing countries either play little role in regional inequality or tend to facilitate regional inequality, though disagreement exists.

While much of the analysis on institutions focuses on nation states, the state is multi-scalar and specific to different historical epochs and world regions (Agnew & Corbridge, 1995). The state acts in the web of global, regional and local forces, and has to adapt to globalization and change. In a more hierarchical state structure like that of East Asia, the state can use a variety of state policies, through taxes, tariffs, finance, access to foreign capital, spatial policy, and state-owned enterprises, to promote economic development, (Appelbaum & Henderson, 1992). Zhang and Bao (2015) find the significant impact of urbanization policies on regional pay inequality in China. While some have observed convergent state policies, others argue there is a decoupling process between state structures and regional outcomes. The state is also dynamic, with

shifting development philosophy, and its policy towards regional inequality. Moreover, global and local forces may force states engage in global competition, which may reduce the effectiveness of state policies in regional development.

Also, the local government is not merely an agent of the central state and may behave differently. The literature has recognized the importance of local governments on local economic development (Robert & Schein, 1993; Valler, 1996). The American-style of federalism with strong local governments is likely to have contributed to spatial equality over time in the United States (Kim, 2008). Worldwide decentralization has empowered local governments who have received considerable decision making powers. They actively initiate conditions favorable to local development and tend to protect the interest of localities. Local governments in China, particularly in the coastal region, have aggressively negotiated with the central government for more favorable policies and have more vigorously promoted foreign investment and trade, which in-turn have contributed to the faster development of the coastal region and the rise of the coast-interior divide (Wei, 2000). The activities of local governments have clearly significantly contributed to the growth of certain regions, and thus to uneven regional development.

Time, evolution, and regional inequality

Regional inequality changes over time. Production system and technical innovation play an important role in the dynamics of regional development. Scholars following Neo-Marxism maintain that the capitalist economy experiences periodic crises and cycles due to changes in profit rates, and stress the dynamics of uneven development and regional inequality. According to Smith (1984), in the process of capital accumulation, initial attractive factors for capital tend to diminish. The periphery with lower wages, less-organized unions, and cheaper land becomes attractive to capital. Capital tends to move back and forth, or “see saw,” between developed and underdeveloped areas, making spatial development a see-saw process of equalization and differentiation. Regions are continuously developed and abandoned due to periodical crises and restructuring of the capitalist economy (Markusen, 1985). Uneven spatial development is always articulated in historically and contextually specific forms (Brenner, 2009).

Researchers have incorporated the production cycle theory to understand regional inequality (Amos, 1990; Booth, 1986; Norton & Rees, 1979). This school believes that regional economies, like national economies, exhibit long wave behaviors, from prosperity to stagnancy, decline, and recovery as the technical innovation life-cycle proceeds. Prosperity provides an impetus for concentration and increased regional inequality while stagnancy prompts the spread of development from the core to the periphery and the decline of regional inequality. Thus, regional inequality rises and falls cyclically, and several inverted-U patterns exist during the process of economic development (Amos, 1990). Some scholars have found the reemergence of regional inequality in major developed countries in the late 1970s or early 1980s which is believed to be consistent with the cyclical process of the long wave (Amos, 1990; Maxwell & Hite, 1992). However, regional development does not necessarily follow the long-wave cycle. Scholars disagree with the timing of long wave cycles and the leading sectors of technical innovation. Also, mature regions may not lose their innovation energy and may still lead in technology (Marshall, 1987). Last, it overlooks many factors, other than technical innovation, that shape the dynamics of regional inequality.

With the development of evolutionary economics and evolutionary economic geography, the time dimension has drawn increasing attention. This has also benefitted from the development

of GIS, especially spatio-temporal models. Convergence or divergence trends depend on the initial levels of development, the choice of time period for study and the level of economic development. Countries at a lower level of development with a faster pace should have an imprint on the behavior of regional inequality. Period of expansion is associated with rising regional inequality (Petrakos et al., 2005). However, economic expansion is not necessarily led by the traditionally richest regions, and its effect on regional inequality also depends on scale, space, and development trajectories of regions (Wei & Ye, 2009). Another important development is the role of geography in intergenerational inequality (Hendren, Kline, & Andaez, 2014), which, however, has yet to receive the full attention of geographers.

Geography, spatiality and regional inequality

Geography matters. An increasing interest in the difference that space makes has emerged since the mid-1980s. Massey argues that “the fact that processes take place over space, the facts of distance, of closeness, of geographical variation between areas, of the individual character and meaning of specific places and regions – all are essential to the operation of social processes themselves” (Massey, 1985). Spatial process and patterns make a difference to broad social, economic, and political process. Diamond (1999) has drawn broad attention on the role of geography or the environment in civilization and economic development. *World Development Report 2009* (World Bank, 2009) highlights the importance of economic geography in regional economic development.

The literature on regional development and inequality is popular with terms related to geography, such as region, spatiality, locality, proximity, district, local context, and neighborhood effect. Spatiality can simply be defined as any property relating to or occupying space such as dimensionality, directionality and spatial configuration. Scholars have found that regional inequality is sensitive to geographical clustering and agglomeration, and that changing trajectories and fortunes of leading or lagging regions often have a huge impact on regional inequality (Ye & Wei, 2005; Yu & Wei, 2003). It has been widely accepted that regional inequality differs greatly across countries, largely shaped by country-specific geographical and institutional factors (Kim, 2008). The questions are: what do these varied terms even as geography and spatiality mean? How does geography matter? How exactly are the spatiality and role of geography measured? Economists have also studied the mechanisms of development and inequality in terms of first nature (physical geography), and second nature (agglomeration). Several lines of research have advanced our knowledge on spatiality of regional inequality.

Scale

Regional inequality is multiscalar in nature. It has been widely documented that regional inequality differs across scale (Kim, 2008; Wei, 1999), as evidenced by papers in this special issue as well (Liao & Wei, 2015; Zhang & Bao, 2015). Most convergence analyses are conducted at the subnational level across first administrative units, and to a less degree, at the national level (e.g., EU). Regional inequality can be manifested at the global scale such as global inequality and the inequality within the European Union. Within a country, the issue can be studied at the regional scale as well as within provinces/states and municipalities. Regional inequality can also be studied from the perspectives of individuals, households and neighborhoods. This special issue has made a major advance in studying regional inequality from household income (Breau, 2015; Dorling, 2015; Essletzbichler, 2015). Sources of regional inequality are also sensitive to scale and change with the

contexts of globalization and region specific factors. Scale is certainly socially constructed, and the process of rescaling underlies the dynamic mechanisms of spatial inequality. A scalar perspective presents a topology of regional inequality, and has the potential to link inequalities at the macro scale to the micro scale, and even everyday life experiences.

Location, physical geography, and amenity

There is a revitalization of the study of the role of location, physical geography (or first nature) and more broadly, amenity, in regional inequality. This drive has a lot to do from the so-called geographical turn in social sciences especially in economics, while geographers are cautious against being labeled as new environmentalists. Geography is fundamental to agricultural development, technological diffusion, disease, and therefore human prosperity (Diamond, 1999; Sachs, 2005). Remote location and poor accessibility are believed to be an important cause of persistent poverty and regional inequality in Africa (Christiaensen, Demery, & Paternostro, 2005; Sachs, 2005). Research has shown the significance of physical geography, such as climate, terrain, and coastal proximity, to regional development and inequality (Gallup, Sachs, & Mellinger, 1999; Glaeser & Kohlhase, 2004; Kanbur & Venables, 2005). Cross-country studies have confirmed the significance of coastal proximity to national variations in income growth (Gallup et al., 1999). US economic activity is overwhelmingly concentrated at its ocean and Great Lakes coasts, reflecting a large contribution of coastal proximity to productivity and quality of life. The effects of climate change differ greatly across nations and regions, and Silva, Matyas, and Cungaara (2015) find that generally weather shocks exacerbate existing economic and income divisions within societies in Mozambique. Resource curse and poverty trap, which significantly contributes to the persistence of poverty and regional inequality, have also been studied.

Place: locality, local context and local agents

Scholars have used a variety of terms to refer to the significance of the local in regional development and inequality, including locality, local context, local agent, local condition, and even region and space (sometimes used interchangeably with place). Local conditions also include location, local transportation, local resources, local labor market conditions, and may also include agglomeration, local institution and local network. Locality, in lay terms, simply refers to region or place. Locality studies in the UK in the 1980s attempted to understand the impact of economic restructuring on regions and places, and stressed that spatiality is central to social life and locality makes a key difference to broad social process (Cooke, 1989; Gregory & Urry, 1985). It has been used as policy of local governments, local labor markets, spatial variation, or anything to do with the local (Cooke, 1989; Cox & Mair, 1991; Johnston, Gregory, & Smith, 1994). Research on production organization and space, particularly the industrial district literature, has shown that local factors, including industrial structure and locational proximity, are critical to flexible production and regional development (Scott, 1998). Localities influence the functioning of global forces and state policy, and vice versa. The local force makes a significant difference to the impact of global forces and state policy, and in many cases, it is the most important force shaping uneven regional development. Methodological developments including distribution dynamics and spatial Markov chain have allowed researchers to more accurately assess the role of place and region in regional inequality.

Space: agglomeration, cluster and region

Space is uneven, and the core-periphery structure has long been central to the study of regional inequality. Regional inequality is heavily influenced by spatial heterogeneity/association and the development trajectories of regions. The regional development literature has also provided a micro-perspective on the nature of uneven development and it being fundamental to the core-peripheral divide and regional inequality. Regional development is often considered as a local process of economic development where region, locality, or local context plays important roles. Locational advantages are strengthened by product specialization and spatial agglomeration, a cumulative causation process leading to reinforced regional inequality. Cronon (1991) argued that once Chicago had established as a central market, the concentration of population and production, and its role as a transportation hub provided the incentive for more concentration of production there. Regions with advantages in local forces and context tend to outgrow others, as evidenced by the industrial district and cluster literature. Innovation research has also examined the role of space in innovation and regional inequality, including regional innovation systems and role of geography and proximity (ÓhUallacháin & Leslie, 2005).

Analyzing spatial association/heterogeneity and regional trajectories can deepen the understanding of regional inequality. Inequality indexes such as coefficient of variation and Gini coefficient are often used to measure regional inequality. Geographical space or regions are heterogenous in nature, which is masked by the conventional inequality indexes. Spatial association indexes, including indices of geographical concentration, global and local Moran's I, as well as a series of distance and spatial interaction based indexes, have been widely used to measure spatial dimension of regional inequality. The development of GIS and spatial analysis has provided powerful tools to uncover the significant impact of spatial association and spatial heterogeneity on regional inequality (e.g., Le Gallo, 2004; Liao & Wei, 2012; Rey & Montouri, 1999; Rey & Sastre-Gutierrez, 2015). Spatio-temporal analysis of income distribution has revealed that regions neighboring richer ones tend to have higher rate of upward mobility (Rey, 2001; Wei et al., 2011). Liao and Wei (2015) find that strengthening spatial dependence accounts for the majority of the core-peripheral divide in China's Guangdong province.

Spatial linkage, network and social media

The significance of spatial linkages and networks is evidenced by the so-called relational turn in economic geography, and the popularity of network studies in geography, regional science and social sciences. Networks specific to certain regions may facilitate knowledge diffusion and promote regional development, so does improvement in infrastructure and spatial linkages. The importance of spatial linkages to regional development has been reemphasized by the research on production organization and regional development, innovation, global cities, and human behavior (Leung, 1996; Scott, 1998). Second nature which represents the endogenous attractiveness of a location emphasizes the interactions between economic agents and especially the agglomeration force that can be caused by the interactions (Kanbur & Venables, 2005). Regional development theories have established that regions close to major economic centers tend to benefit from the trickle-down effect of these centers, which have been illustrated by empirical studies using spatial Markov chain (Liao & Wei, 2015). Networks are hierarchical and stratified, and may also contribute to and sustain the core-periphery structure of regions (Wei & Ye, 2009). Poon et al. (2015) find that the financial human

capital network is structured spatially around hubs and peripheral cities, creating wage differences between cities. Investment in infrastructure, especially localized infrastructure projects, can improve spatial linkages and access to markets, and reduce distance and spatial barriers to development (Rodríguez-Pose & Hardy, 2015). The popularity of social media provides new tools to study the nature of human behavior and spatial interaction. Social media has also produced new space of inequality, which has yet to be fully understood.

Geographical synthesis and spatial-temporal models

It is necessary to separately analyze factors of regional development, but too often theories of regional inequality stress a singular variable, such as factor mobility or dependency. Too often analysts embrace a singular epistemological view, and consider their perspectives competing rather than complementary. It has been argued that institutions, rather than geography, play determining role in regional development and inequality (Acemoglu & Robinson, 2012); however, interactions between institutions and geography and the role of geography in the success or failure of state policies have not been thoroughly studied. Geographers have demonstrated the limited power of a single theory and suggested that multi-perspective synthesis might be necessary for better research (Brown, 1991; Clark, 1987).

Scholars have suggested that three levels of mechanisms, world economy, nation-state, and locality, are critical to geographical inquiry. Brown (1991) argues that place characteristics associated with development played a major role in societal processes, and considers Third world development as the local articulation of world economic and political conditions, donor-nation actions, and government policies. Taylor (1993) employs three scales of analysis – world system, nation-state, and locality – to represent a global scale of reality, a national scale of ideology, and a local scale of experience. Agnew and Corbridge (1995) inform us the importance of international political economy, institutions, and territories in the understanding of space and geopolitics. The multi-scale and multi-mechanism framework of regional inequality in China argues that global restructuring and economic reforms have stimulated decentralization, marketization, and globalization in China; consequently, the state, the locality and the foreign investor function simultaneously to shape regional inequality at including interregional, interprovincial and intraprovincial scales (Wei, 1999, 2000). This framework has been applied in many studies (e.g., Li & Wei, 2014; Liao & Wei, 2015; Wei & Fan, 2000). Breau (2015) distinguishes four broad sets of mechanisms (economic, socio-demographic, spatial, institutional) underlying rising inequality in Canada.

Multiple forces and factors contribute to regional inequality, which exhibits spatial and temporal patterns. Agents of development may strengthen or counter with one another in driving regional convergence or divergence. Local forces may act against equalization policies and limit the effectiveness of state policy. The interaction between global forces and localities is complicated, although the literature suggests that global forces tend to strengthen the core regions that provide favorable conditions for foreign investment. GIS provides powerful tools for analysis, such as spatial association indexes, spatial regression, geographically weighted regression, geographically weighted logistic regression, and spatial regime models. The application of these new tools and methods has significantly advanced the study of regional inequality. We now understand much better the role of geography and the spatiality and dynamics of regional inequality. The recent development in data science, especially big data, will provide more tools for a fuller understanding of the multi-facets of regional inequality.

Conclusion

This paper has reviewed the massive literature on regional inequality, which is a challenging task. Existing theories disagree over temporal trends and underlying forces of regional inequality. The neoclassical convergence model maintains that efficient markets and factor mobility tend to equalize regional differentials. The inverted-U model suggests that regional inequality tends to rise during the early stage of development and fall as the economy matures. The divergence and structural models argue that regional inequality is inevitable under capitalism and tends to be maintained and intensified. The product cycle model highlights technological change and views regional inequality behaving cyclically. Scholars have also emphasized the significance of institutions and geography in uneven development, and increasingly favor spatio-temporal models.

This special issue has made an ambitious effort to study regional inequality in the world, including both developed and developing countries. It has showcased the most recent development in geographical research on regional inequality, with an emphasis on space and spatiality. While these studies focus on economic/income inequality, we also encourage authors to broaden the scope of their research to include social and environmental inequalities, such as Silva et al. (2015).

Regional inequality is multi-scalar in nature, and geographical work on regional inequality tends to be at the meso-scale. The scale of global and individual/household inequalities has received much less attention. The authors have made a major advance in regional inequality through studying spatial household income inequalities in the United States, Canada and United Kingdom, which tend to intensify over time (Breau, 2015; Dorling, 2015; Essletzbichler, 2015). Household income data provide tremendous opportunities for future research on spatial inequality. Geographers also tend to pay less attention on rural inequalities, including inequality across villages. This special issue has made an important contribution to better understanding of rural inequality, and promoting the spatial perspective in rural development (Rodríguez-Pose & Hardy, 2015; Silva et al., 2015). More work at global, individual, household and rural inequalities is still needed.

Regional inequality is also influenced by forces operating at multiple scales, as shown by papers in this special issue (e.g., Breau, 2015; Liao & Wei, 2015). Regional development positively relates to effective local state initiatives and favorable local conditions that may include local development path, economic structure, spatial linkages, and local resource endowments. Regions with advantages in these local agents and context tend to outgrow others, leading to persistent or even widening regional inequality. The interaction of global forces and localities is complicated but as suggested by the literature, foreign investment and trade tend to strengthen the core regions with advantages in local conditions and international connectivity. Core regions, however, may be vulnerable to global shocks such as climate change and financial crises. Studying policies to cope with globalization and environmental change and promoting regional resilience are therefore also needed.

While this special issue focuses on economic/income inequality, regional inequality has many different dimensions. Recent work has expanded the research scope rapidly, especially in social and environmental inequalities, including health, education, political participation, crime, environment and more broadly, human development. Health inequality and environmental justice have drawn particular attentions of geographers, especially those based in the United States and at the urban scale, while other aspects of spatial inequality have received much less attention by human geographers. There are also interactive effects among the multiple dimensions of spatial inequality, which needs more studies as well.

We have to ask normative questions of the nature of regional inequality and how it should be addressed (Pike, Rodríguez-Pose, & Tomaney, 2007). Essletzbichler (2015) suggests that cities with higher income inequality tend to be more segregated. More efforts should be made in the study of the effects of spatial inequality, and the broad issues of social justice, governance, humanity and sustainability.

As more data become available, spatial and temporal dimensions can be further expanded. With the development in GIS, spatio-temporal models have become powerful tools in understanding the dynamics of regional inequality. Big data will certainly provide new tools to enhance the research. The dynamics and complexity of regional inequality not only makes the study of regional inequality a challenging task but also provides endless opportunities for future research. We are excited about the potential of GIS and big data, and encourage more GIS, social media and big data professionals to get involved in the study of spatial inequality.

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